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PATENT ABSTRACTS OF JAPAN

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(54) ROUTE CONTROL METHOD AND APPARATUSAND COMPUTER PROGRAM

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a route control method and apparatusand a computer program that can create and select a route wherein a few number of duplicate links and duplicate nodes are present.

SOLUTION: The route control method in a network tentatively formed among a plurality of nodes includes: a step of broadcasting a detection request of a destination node; a step S1 of receiving a response (RREP) from the destination node in response to the detection request; steps S3S5 of referencing the number of joints included in the response and registering the number; a step S9 of incrementing the number of joints by '1' and transmitting the result when there are a plurality of links (feedback paths) that transmit their responses; and a step of selecting a link whose number of registered joints is smallest as a route when there are a plurality of links for transmitting data to the destination node.

CLAIMS

[Claim(s)]

[Claim 1]

It is a path control method in a network temporarily formed among two or more nodes

A process in which a discovery request of a destination node is broadcast

A process in which a response from a destination node to said discovery request is received

A process registered with reference to the number of joint contained in said

response

A process in which add 1 to said number of joint and it transmits to it when there are two or more links which transmit the response concerned

A process in which a link with said registered smaller number of joint is chosen as a course when there are two or more links which transmit data to said destination node

A ****(ing) path control method.

[Claim 2]

A process in which said registered number of joint will be changed if the number of joint contained in the another response concerned is larger than the number of joint contained in the first response when another response is received after reception of said response

The path control method according to claim 1 having in a pan.

[Claim 3]

The path control method according to claim 1 or 2 when a purport of unlinking is received wherein a link which transmits data to said destination node performs control which does not send a purport of unlinking with plurality.

[Claim 4]

It is a device which controls a course in a network formed temporarily among two or more nodes

It is provided in said each node

A discovery request of a destination node is broadcast

A response from a destination node to said discovery request is received

It registers with reference to the number of joint contained in said response

When there are two or more links which transmit the response concerned 1 is added to said number of joint and it transmits to it

A path control apparatus characterized by choosing a link with said registered smaller number of joint as a course when there are two or more links which transmit data to said destination node.

[Claim 5]

It is a computer program for controlling a course in a network formed temporarily among two or more nodes

A process in which a discovery request of a destination node is broadcast

A process in which a response from a destination node to said discovery request is received

A process registered with reference to the number of joint contained in said response

A process in which add 1 to said number of joint and it transmits to it when there are two or more links which transmit the response concerned

A process in which a link with said registered smaller number of joint is chosen as a course when there are two or more links which transmit data to said destination node

A computer program performing a computer.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to the path control method and device in networks temporarily formed among two or more nodes such as what is called a multi-hop network and a computer program.

[0002]

[Description of the Prior Art]

The research and development what is called about a multi-hop (or ad hoc) network have started. This multi-hop network is a network constituted by the meeting of a node with the function as a router.

For example it is temporarily formed among two or more terminals in which short distance communication is possible and the home network to which interconnection of the information home appliance is carried out by the radio called Bluetooth a temporary network in the conference hall etc. are assumed.

[0003]

By the way as shown in drawing 11 the course of a before [transmission source node S of data and destination node D] is provided by set of the nodes N1-N4 which relay a data packet. In this case when the node N1 moves out of this network for example the link between N1 and S is cut but since the course between S-N3-N4-D remains the course here can be chosen and course restoration can be performed promptly.

[0004]

On the other hand as shown in drawing 12 when the link between S-N1 overlaps and this link is cut courses will be cut [no] and course restoration becomes impossible. Since it is such it is required to perform path control so that a course as shown in said drawing 11 may be created.

[0005]

Since it is such there is a technique called DSR (Dynamic Source Routing) and AODV (Ad hoc On-demand Distance Vector Protocol) as path control in an ad hoc network. Furthermore the latter, Extended AOMDV (Ad hoc On-demand, Multipath Distance Vector, Protocol) is advocated (M. K. Marina and S.R. Das In Proceedings of the International Conference for Network protocol Nov. 2001).

[0006]

This AOMDV method is a protocol which creates two or more courses without a duplication link like said drawing 12. The course creation procedure in AOMDV is explained with reference to drawing 13. First S broadcasts the message (RREQ) for searching for D. There is a field which registers the address of the node which received first in this message and it is un-registering at the time of transmission of S. N1 and N2 which received the message from S get to know that self is the node

which received this message first and they register and broadcast a self address to a described area respectively. Although the node I overlaps and receives the message from N1 and N2 it acquires and broadcasts only the message of a direction (a figure N1) which received first and others reject it. Henceforth a message relays N3 and N4 respectively and reaches to D and a transfer path is acquired. If each node carries out the unicast of the response to the node N3 which D broadcast that a message was and the node which carried out the unicast of the response message (RREP) to N4 and was broadcast after that a feedback path contrary to a transfer path will be created.

[0007]

The feature of the AOMDV method is at the following point. Usually if duplication reception of the broadcast message is carried out the message from after will be rejected unconditionally but. in the AOMDV method when the message (N1) and address which receiving node (I) already received with reference to the above-mentioned address registered area in a message differ from each other processing which updates a feedback path is performed (the unicast of the RREP is carried out to the transmitting origin) -- it is like. Thereby since I becomes a relay node which forms a link respectively separate from N1 and N2 and a link intersects the course which does not have a duplication link as a result accomplishes two or more works.

[0008]

[Problem(s) to be Solved by the Invention]

However in the case of the above-mentioned technique there are the following problems. That is as shown in drawing 14 it is equivalent to the node I and when two or more relay node X which two or more links intersect and Y exist the fault that duplication link X-N3-Y arises is between relay node X and Y. This is based on the following reason. First although the node X receives a RREQ message from N1 and N2 it broadcasts only the message (N1) which received first. Although this message is broadcast by the node Y via N3 and N4 respectively since these addresses are the same (N1) the message from after is rejected unconditionally at Y. As a result since the course which passes along N4 of the rejected direction is not formed the above-mentioned duplication link will produce it.

[0009]

In the network which this invention was made in view of the above-mentioned problem and is temporarily formed among [such as an ad hoc network] two or more nodes it aims at providing creation a selectable path control method a device and a computer program for a course with few duplication links and duplication nodes.

[0010]

[Means for Solving the Problem]

In order to attain the above-mentioned purpose as for this invention the path control method according to claim 1 is characterized by that a path control method in a network temporarily formed among two or more nodes comprises the following.

A process in which a discovery request of a destination node is broadcast.

A process in which a response from a destination node to said discovery request is received.

A process registered with reference to the number of joint contained in said response.

A process in which add 1 to said number of joint and it transmits to it when there are two or more links which transmit the response concerned and a process in which a link with said registered smaller number of joint is chosen as a course when there are two or more links which transmit data to said destination node.

Since the number of joint is increased and a course with few joint was chosen when two or more links were connected with a situation with two or more links which transmit said response i.e. one node when done in this way a course with which two or more links are connected can be avoided to one node and a course with few duplication links and duplication nodes can be created and chosen as it.
[0011]

If the number of joint contained in the another response concerned is larger than the number of joint contained in the first response when another response is received after reception of said response it is preferred to have further a process in which said registered number of joint is changed.

Since the largest number of joint will be registered into a node which received a response if it does in this way a network state is correctly reflected in the number of joint and channel selection based on the number of joint can be performed correctly.

[0012]

When a purport of unlinking is received it is preferred that a link which transmits data to said destination node performs control which does not send a purport of unlinking with plurality.

If it does in this way all the nodes which received a purport of unlinking will send this further and fault which causes useless data processing in the network increase of traffic and each node etc. will be prevented.

[0013]

A path control apparatus of this invention is a device which controls a course in a network formed temporarily among two or more nodes. It is provided in said each node broadcast a discovery request of a destination node and a response from a destination node to said discovery request is received. When there are two or more links which register with reference to the number of joint contained in said response and transmit the response concerned. When there are two or more links which add 1 to said number of joint transmit to it and transmit data to said destination node a link with said registered smaller number of joint is chosen as a course.

[0014]

A process in which is for a computer program of this invention controlling a course in a network formed temporarily among two or more nodes and a discovery request of a destination node is broadcast. A process in which a response from a

destination node to said discovery request is received and a process registered with reference to the number of joint contained in said response. A process in which add 1 to said number of joint and it transmits to it when there are two or more links which transmit the response concerned. When there are two or more links which transmit data to said destination node a computer is made to perform a process in which a link with said registered smaller number of joint is chosen as a course.

[0015]

[Embodiment of the Invention]

Hereafter an embodiment of the invention is described with reference to each figure. Drawing 1 is an example of the configuration block figure of the node (terminal) which forms a temporary network with which this invention is used. In this invention each node shall turn into transmission source node S destination node D and the node (relay) N respectively.

[0016]

In this figure each node. Via the control section (path control apparatus) 2 which controls the whole the application (computer program) 4 which recorded the various processing performed by this invention the protocol part 6 which performs predetermined protocol control the routing parts 8 which perform a routing function and the wireless communication antenna 10a. It has the path control table 12 which registers the variety of information for the wireless section 10 for performing other nodes and radio and path control.

[0017]

As for drawing 2 drawing 3 shows the format of a response message [as opposed to it for the format of the discovery request message (RREQ) of a destination node] (RREP). In drawing 2 the address (Source IP address) of the sending person of RREQ is recorded on the IP header including the AODVM message which uses RREQ by the IP header and a UDP header and this invention. Destination IP of an AODVM message An address and Originator IP As for an address address (D) and transmitting origin specifies (S) respectively. This format is the same as that of what is used by the conventional AODV.

[0018]

As for RREP in drawing 3 the address (Source IP an address and Destination IP address) of the transceiver person of RREP is recorded on the IP header including the IP header the UDP header and the AODVM message respectively. In an AODVM message although it is the feature of this invention to newly have provided the joint count field this is mentioned later.

[0019]

Next the general procedure of the path control which the node which received the above-mentioned RREQ and RREP performs is explained with reference to drawing 4. In this figure the case where a course is created between transmission source node S the relay node N and destination node D is considered. First S broadcasts RREQ (broadcasting). RREQ **** NA and NB in order and reaches to D. At this time NA and NB register the following information as a "feedback path"

to the path control tables 12A and 12B of self respectively. This feedback path is a course for returning to S and registers into the item "Next hop" from which node RREQ was received for "S" in the item "Destination." Refer to the IP header of RREQ for from which node RREQ was received.

[0020]

On the other hand D will transmit RREP to the transmitting origin referred to from the IP header of RREQ if RREQ is received (unicast). RREP **** NB and NA in order and reaches to S. At this time NA and NB register the following information as a "transfer path" to the path control tables 12A and 12B of self respectively. This transfer path is a course for sending data to D and registers into the item "Next hop" from which node RREP was received for "D" in the item "Destination." Refer to the IP header of RREP for from which node RREP was received. If a feedback path and a transfer path are acquired as mentioned above the course between nodes will be formed.

[0021]

Next the path control in a actual network is explained. Drawing 5 is a figure showing the composition of the whole network formed of each node. In this figure a network is formed of S and two or more relay nodes N10-N16. A solid line shows the link (wireless communication network) formed between each node.

[0022]

And in this network supposing S broadcasts RREQ each node will record the node which serves as a course (feedback path) to S based on RREQ which received on the path control table of self. The arrow S of the figure expressed the feedback path of each node and has pointed out the node used as the course to S in the direction of an arrow. If RREQ is broadcast by even D D will transmit RREP (unicast). By transmitting RREP which each node which received RREP received toward S using the created feedback path already RREP reaches even S. At this time each node records the node which serves as a course (transfer path) to D based on RREP which received on the path control table of self. The arrow D of the figure expressed the transfer path of each node and has pointed out the node used as the course to D in the direction of an arrow. When it does in this way in the example of a figure a feedback path and a transfer path will certainly be created between each node. Since RREQ which came later depending on the address registered area in RREQ is not canceled like the conventional AOMDV method it becomes impossible that is to create the course which does not overlap since a course is not created between nodes.

[0023]

However when using the created course at random simple two or more courses will be created and a course including a duplication link exists in it. Then the following processings are provided and it enables it to choose the course which does not include a duplication link.

In this processing each node performs the procedure (flow) shown in drawing 6. In this figure each nodes N10-N16 receive RREP first (Step S1). joint count shown in said drawing 3 at RREP The field is provided and refer to the value (the number of

joint) for each node (Step S3). Here the number of joint is set as 0 when destination node D transmits RREP first. Each node registers the value (the number of joint) referred to for every transfer path of a path control table (Step S5).

[0024]

Next with reference to the path control table of self it is judged whether each node has two or more feedback paths which should transmit this RREP (Step S7).

Here it is judged whether two or more nodes are registered into the item "Next hop" in a feedback path. In "Yes" each node is joint count of RREP at Step S7. 1 is added to the value of the field and it transmits to the node of a transmission destination (Next hop) (step S9). On the other hand in "No" each node transmits RREP to the node of a transmission destination at Step S7 with the value (it was referred to) of a basis (Step S11).

[0025]

Drawing 7 and drawing 8 show the data of the path control table of each node in processing of said drawing 6. Drawing 7 and drawing 8 are data of the node N16 of said drawing 5 and the path control table of N14 respectively.

[0026]

In drawing 7 since N16 receives RREP directly from D the number of joint contained in RREP is 0. Therefore 0 is registered into the "joint count" field of a transfer path (transmission path to D). on the other hand -- the feedback path of N16 -- two N13 and N15 -- it is . Therefore since judgment of the above-mentioned step S7 serves as "Yes" N16 transmits RREP (1 was added to 0) which set the number of joint to 1 to N13 and N15 respectively.

[0027]

In drawing 8 N14 receives RREP from N13 and N15 respectively. Here as shown in drawing 9 the number of joint of RREP to which the number of joint of RREP transmitted from N13 is transmitted from 2 and N15 is 1. Therefore the inside "next hop" of a transfer path (transmission path to D) registers "2" into the "joint count" field of N13 and "next hop" registers "1" into the "joint count" field of N15. On the other hand the number of the feedback paths of N14 is one and since judgment of the above-mentioned step S7 serves as "No" N14 transmits RREP which does not change the number of joint of a basis to S.

[0028]

By the way like the node N14 when there are two or more transfer paths the following problems arise. That is which value should be registered into the path control table of self among the numbers of joint by which the node which transmits RREP to S which is a feedback path is contained in RREP which S received from each node since only the number of transfer paths overlaps poses a problem. Then if the receiving node (S) of RREP has the number of joint larger than the number of joint already registered into the table in RREP which received later when RREP another after receiving RREP is received it will change the number of joint. Since the largest number of joint will be registered into the receiving node of RREP if it does in this way a network state is correctly reflected in the number of joint and channel selection based on the number of joint can be performed

correctly.

[0029]

By the above processing as it is shown in drawing 9 the number of joint for every transfer path is registered into the table of each node. In this figure although there are N10 and N14 as a transfer path of S the arrow D in a figure shows a transfer path and that subscript (2) shows the number of joint.

[0030]

Next how to choose a course using the number of joint of above-mentioned drawing 9 is explained. First S transmits the data (packet) which the number of joint transmits to the address D between two transfer paths N10 and N14 using few directions with reference to the path control table of self. Here since any number of joint of a transfer path is the same value (2) S determines a transfer path at random. At drawing 9 it is the transfer path 1. It should *****.

[0031]

Next N10 which received data transmits data with reference to the path control table of self using a direction with few numbers of joint between two transfer paths N11 and N13. Since the number of joint has here few transfer paths which relay N11 it is the transfer path 2. It *****. Hereafter since the number of transfer paths is one in the case of N11 and N12 it is the transfer path 3. 4 It *****. Thus 1-4 Although ***** is chosen since the relay node which duplication-links or overlaps does not exist this course is a course with few troubles such as course cutting. Similarly the relay node to which it duplication-links or the course of S-N14-N15-N16-D also overlaps does not exist.

[0032]

By the way when course cutting arises the node located in the cut link broadcasts the error message which tells the purport of cutting using a feedback path. However if all the nodes which received this message broadcast a message further useless data processing in the network increase of traffic and each node etc. may be caused. Then in this embodiment as it is shown in drawing 10 the transmission control of an error message is performed.

[0033]

Suppose that the link between N12-D was cut in drawing 10 (course 1). N12 located in a cutting link detects cutting and broadcasts an error message (the arrow E of a figure). Here broadcast of 1HOP is considered. N11 which received the message gets to know that the number of transfer paths is one (from N11 to N12) with reference to the path control table of self. Each node gets one transfer path blocked when there is no alternate route which avoids a cutting link an error message is broadcast and N11 broadcasts an error message. N11 sets again the flag of the purport that course cutting was carried out to the transfer path of a path control table.

[0034]

On the other hand with reference to the path control table of self as for N13 which received the error message from N12 two transfer paths (from N13 to N13 to N12 and N16) get to know a certain thing. Since each node chooses other alternate

routes which do not go via a cutting link without broadcasting an error message when there are two transfer paths N13 does not broadcast an error message. Since similarly N10 which received the error message from N11 has two transfer paths (from N10 to N10 to N11 and N13) an error message is not broadcast. Thus the broadcast numbers of an error message can be reduced to the minimum. N13 and N10 set the flag of the purport of opposite *Perilla frutescens* (L.) Britton var. *crispa* (Thunb.) Decne. to that by which course cutting was carried out among the transfer paths of the path control table of self.

[0035]

Next the selection method of the alternate route based on the above-mentioned error message is explained. First the number of joint makes channel selection of either at random from two transfer paths the N10 [same] and N14 the same with having explained in said drawing 9 and S transmits the data transmitted to the address D. Here when the course N14 is chosen it is as having already stated that the course 3 in which neither the duplication link S-N14-N15-N16-D nor the overlapping relay node exists is chosen. On the other hand when the course N10 is chosen N10 gets to know that the course which goes to N11 is cut with reference to the flag of the transfer path of a path control table. Then N10 chooses a transfer path (course which goes to N13) without a flag and transmits data. N13 which received data chooses similarly a transfer path (course which goes to N16) without a flag with reference to a path control table and transmits data. And N16 transmits data to D. Thus the course 2 is chosen.

[0036]

The path control method of this invention A computer and various peripheral equipments such as a communication apparatus The software program executed by the computer can realize and the software program executed within the above-mentioned system can be distributed via the storage or communication line in which computer reading is possible.

[0037]

[Effect of the Invention]

The situation which has two or more links which transmit said response according to this invention according to claim 1 as explained above That is since the number of joint is increased and the course with few joint was chosen when two or more links had led to one node the course with which two or more links are connected can be avoided to one node and a course with few duplication links and duplication nodes can be created and chosen as it. Also when a predetermined course is cut with reference to the number of joint an alternate route can be chosen promptly.

[0038]

According to this invention according to claim 2 since the largest number of joint is registered into the node which received the response a network state is correctly reflected in the number of joint and channel selection based on the number of joint can be performed correctly.

[0039]

According to this invention according to claim 3 all the nodes which received the

purport of unlinking send this further and the fault which causes useless data processing in the network increase of traffic and each node etc. is prevented.

[Brief Description of the Drawings]

[Drawing 1] It is a figure showing the configuration block of the node (terminal) which forms a temporary network.

[Drawing 2] It is a figure showing the format of the discovery request message (RREQ) of a destination node.

[Drawing 3] It is a figure showing the format of the response message (RREP) over RREQ.

[Drawing 4] It is a figure showing the general procedure of the path control which a node performs.

[Drawing 5] It is a figure showing the composition of the whole network formed of each node.

[Drawing 6] It is a figure showing the flow which each node which received RREP performs.

[Drawing 7] It is a figure showing the data registered into the path control table according to the flow of drawing 6.

[Drawing 8] It is another figure showing the data registered into the path control table according to the flow of drawing 6.

[Drawing 9] It is a figure showing the number of joint set as each link.

[Drawing 10] When course cutting is carried out it is a figure showing the procedure which chooses an alternate route.

[Drawing 11] It is a figure showing the channel selection of the conventional multi-hop network.

[Drawing 12] It is another figure showing the channel selection of the conventional multi-hop network.

[Drawing 13] It is another figure furthermore the channel selection of the conventional multi-hop network is shown.

[Drawing 14] They are other figures showing the channel selection of the conventional multi-hop network.

[Description of Notations]

S1 Process in which the response (RREP) from the destination node to the discovery request of a destination node is received

S3S5 Process registered with reference to the number of joint contained in a response

S9 Process in which add 1 to the number of joint and it transmits to it when there are two or more links (feedback path) which transmit a response

DESCRIPTION OF DRAWINGS

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